

What is claimed is:

1 1. A method of treating a site comprises:
2 sparging the site with an air/ozone gas stream
3 delivered with a hydroperoxide, which is a substantial
4 byproduct of a reaction of a contaminant present in the
5 aquifer or soil formation with the ozone.

1 2. The method of claim 1 wherein the air/ozone gas
2 stream is delivered through a microporous diffuser that
3 delivers the air/ozone gas in microbubbles.

1 3. The method of claim 1 wherein the hydroperoxide is
2 selected from the group consisting of formic peracid,
3 hydroxymethyl hydroperoxide, 1-hydroxylethyl hydroperoxide,
4 and chloroformic peracid or their derivatives.

1 4. The method of claim 1 wherein the hydroperoxide is
2 selected based on the type of contaminant present in the
3 site.

1 5. The method of claim 1 wherein the hydroperoxide is
2 delivered as a surface layer over microfine bubbles
3 including air/ozone gas stream.

1 6. The method of claim 1 wherein sparging comprises:
2 introducing air including the oxidizing gas into
3 the microporous diffuser.

1 7. The method of claim 1 wherein the sparging
2 comprises:
3 introducing hydroperoxide as a liquid into the
4 microporous diffuser.

1 8. The method of claim 1 wherein the microporous
2 diffuser includes promoters or nutrients such as catalyst
3 agents including iron containing compounds such as iron
4 silicates or palladium containing compounds such as
5 paladized carbon and platinum.

1 9. The method of claim 1 wherein the microporous
2 diffusers have a pore size in the range of about 1 to 200
3 microns.

1 10. The method of claim 1 wherein the hydroperoxides
2 are byproducts of a reaction involving the volatile organic
3 compound with ozone.

1 11. An apparatus for treating subsurface water
2 comprises:

3 a well having a casing with an inlet screen and
4 outlet screen to promote a recirculation of water into the
5 casing and through surrounding ground area.

6 at least one microporous diffuser disposed in the
7 injection well that allows delivery of a first and second
8 fluids with one of the fluids forming a coating over the
9 other of the fluids;

10 an ozone generator;

11 an air compressor and compressor/pump control
12 mechanism to deliver ozone (O₃) from the ozone generator to
13 the microporous diffuser as one of the fluids;

14 a source of the liquid hydroperoxides selected
15 from the group consisting of formic peracid, hydroxymethyl
16 hydroperoxide, 1-hydroxyethyl hydroperoxide, and
17 chloroformic peracid or their derivatives; and

18 a feed mechanism to deliver the selected liquid
19 hydroperoxide to the microporous diffuser as the second one
20 of the fluids.

1 12. The apparatus of claim 11 wherein the feed
2 mechanism is a pump.

1 13. The apparatus of claim 11 wherein air ozone is
2 delivered to a central inner chamber of the microporous
3 diffuser and the liquid hydroperoxide is delivered to an
4 outer chamber of the microporous diffuser.

1 14. The apparatus of claim 11 wherein the microporous
2 diffuser has a porosity characteristic that permits bubbles
3 of 5-200 microns diameter to be released into the
4 surrounding formation.

1 15. An apparatus for treating subsurface water
2 comprises:

3 an sparging apparatus that is disposed through a
4 soil formation, the sparging apparatus comprising:

5 a microporous diffuser positioned through a bore
6 hole disposed through the soil formation or of a type that
7 is injected into the soil formation;

8 a treatment control system comprising:
9 an air compressor that feeds a mixture of
10 air/ozone into the microporous diffuser and
11 a feed mechanism to supply to the diffuser a
12 liquid decontamination agent comprising a hydroperoxide.

1 16. The sparging apparatus of claim 15 wherein the
2 microporous diffuser is disposed through a vadose zone and
3 an underlying aquifer in the soil formation.

1 17. The sparging apparatus of claim 15 wherein the
2 microporous diffuser is coupled to appropriate piping to
3 connect sources of decontamination agents to the microporous
4 diffuser.

1 18. The sparging apparatus of claim 15 wherein when
2 fluid is injected through the microporous diffuser the
3 microporous diffuser enables a water pattern to evolved
4 about diffuser where light bubbles tend to travel upwards
5 and heavier bubbles tend to travel downwards.

1 19. The apparatus of claim 15 wherein the microporous
2 diffuser has a porosity characteristic that permits bubbles
3 of 5-200 microns diameter to be released into the
4 surrounding formation.